

Ford F-250

Bi-Fuel Propane Pickup



The U.S. Department of Energy (DOE) is promoting the use of alternative fuels and alternative fuel vehicles (AFVs). To support this activity, DOE has directed the National Renewable Energy Laboratory (NREL) to conduct projects to evaluate the performance and acceptability of light-duty AFVs. We tested a 1999 F-250 bi-fuel propane pickup. The vehicle was run through a series of tests while operating on LPG and gasoline. The tests are explained briefly below. Detailed descriptions are given on the vehicle evaluation Web site at http://www.ott.doe.gov/otu/field_ops/nve

Acceleration: Three tests performed: (1) elapsed time from a standstill to 60 mph at wide open throttle, loaded and unloaded; (2) elapsed time from 40 to 60 mph at wide open throttle (passing simulation); (3) elapsed time and maximum speed at a quarter mile. Values are the average of six measurements.

Braking: Dry surface is concrete, wet surface is low friction jennite pad. Minimum stopping distance from 62 mph (100 km/h) on dry surface, and from 31 mph (50 km/h) on wet surface with no wheels locked. Panic stops are minimum measured distance from 31 mph (50 km/h) on wet and dry surfaces at maximum pedal pressure with no attempt to steer. Values are average of six stops.

Fuel Economy: City fuel economy determined using an urban driving cycle—a distance of 2 miles with 8 stops. Highway fuel economy used a 70 mph average driving cycle with no stops. The 150 mile trip alternated between urban and highway cycles until 150 miles were reached. Results are reported in 70% highway driving for total trip.

Cold Start: Vehicle placed in a temperature-controlled room at -20°F for first test (minimum soak time 12 hr*). Crank time and idle rating recorded. If start successful, procedure repeated at -20°F for confirmation. If start unsuccessful, procedure repeated at higher temperature until minimum temperature is determined.

Driveability and Handling: Four different drivers rated each aspect of the vehicles; final rating is average of the four.

Emissions: Duplicate tests performed on each vehicle using EPA's Federal Test Procedure. The bi-fuel pickup was tested on both LPG and RF-A (industry average gasoline).

*Soak time allows the vehicle to stabilize at a given temperature.

In 1998, Ford Motor Company introduced its first propane/gasoline-powered bi-fuel F-series pickup with a 5.4L engine (previous propane models featured the 4.9L engine). A bi-fuel vehicle has two separate fuel systems that enable the engine to operate on either propane or gasoline, but not at the same time.*

For this project, we tested the improved 1999 model year, an F-250 with a 5.4L V8 Triton bi-fuel propane/gasoline engine. The propane tank, which holds 26.8 gallons of propane, is installed in the bed of the pickup. The gasoline tank holds 30 gallons, for a combined total of nearly 57 gallons of fuel. Based on the fuel economy tests we performed, this results in a range of 225–300 miles on propane plus 340–490 miles on gasoline. The engine in this vehicle is designed to start on propane. When the propane level in the tank falls below a set limit, the engine automatically switches to gasoline. Improvements for the 1999 model year include modifications for better fuel flow, which increases engine power. Emissions certification levels were also improved, from the low-emission vehicle (LEV) standard in 1998 to the ultra low-emission vehicle (ULEV) standard for 1999. The F-series truck comes in a variety of options to meet individual fleet needs, such as 2- or 4-wheel drive, and regular or SuperCab.

**Or liquefied petroleum gas (LPG).*

General Description

Engine:

Displacement
Configuration
Transmission
Fuel System
Engine Family Code
Compression Ratio

Capacities:

Fuel
Passengers
Cargo (cu ft)

Dimensions:

Length
Width
GVWR*

Bi-Fuel F-250 XLT

5.4 liter
V8
4-speed automatic overdrive
Sequential electronic fuel injection
XFMXA05.4JGC
9.0:1

26.8 gal LPG/30 gal gasoline
3 front/2 rear
46.7

224.2 in.
65.2 in.
6800 lb

Other Options:

Rear wheel drive, 4X2, SuperCab truck equipped with air conditioning, power steering, power brakes, tilt wheel, antilock brake system (ABS), and cruise control. This vehicle was also equipped with front and rear disk brakes.

*gross vehicle weight rating

Performance

Acceleration

	Bi-Fuel LPG	Gasoline
0 to 60 mph loaded (sec)	12.09	11.81
0 to 60 mph unloaded (sec)	9.96	9.31
40 to 60 mph (sec)	5.06	4.99
1/4 mile time (sec)	17.62	17.11
1/4 mile speed (mph)	78.82	81.02

Fuel Economy (mpg)

	Bi-Fuel LPG	Gasoline
City	8.4	11.4
Highway	11.8	16.3
Combined City/Highway	10.7	14.9

Braking

	Bi-Fuel			
	LPG		Gasoline	
Effectiveness stops:	meters	feet	meters	feet
62 mph (100 kph)	52.6	172.5	52.5	172.2
dry pavement				
31 mph (50 kph)	32.0	104.8	31.2	102.2
wet jennite				
Panic stop				
31 mph (50 kph)	14.7	48.3	14.2	46.7
dry pavement				
31 mph (50 kph)	32.8	107.7	32.0	104.8
wet jennite				

Cold Start

Temperature °F	Bi-Fuel LPG crank time	idle rating	Gasoline crank time	idle rating
-20	Did not start*		4.5	7
+20	4	7	—	—

Idle ratings from 1 to 9, 1 being lowest rating

*Vehicle default to gasoline below +20 degrees F

Subjective Ratings:

Routine handling
Emergency handling
Acceleration
Braking
Ride; fully loaded
Ride; lightly loaded
Noise
Driving position
Front seat comfort
Rear seat comfort
Climate control
Access
Controls & displays
Cargo Area

Bi-Fuel

LPG Gasoline

Routine handling: ■ (LPG), ■ (Gasoline)
 Emergency handling: ■ (LPG), ■ (Gasoline)
 Acceleration: ● (LPG), ★ (Gasoline)
 Braking: ★ (LPG), ★ (Gasoline)
 Ride; fully loaded: ■ (LPG), ■ (Gasoline)
 Ride; lightly loaded: ■ (LPG), ■ (Gasoline)
 Noise: ■ (LPG), ■ (Gasoline)
 Driving position: ■ (LPG), ■ (Gasoline)
 Front seat comfort: ★ (LPG), ★ (Gasoline)
 Rear seat comfort: ■ (LPG), ■ (Gasoline)
 Climate control: ★ (LPG), ★ (Gasoline)
 Access: ■ (LPG), ■ (Gasoline)
 Controls & displays: ★ (LPG), ★ (Gasoline)
 Cargo Area: ● (LPG), ● (Gasoline)

★ = Excellent ■ = Good ● = Fair ○ = Poor □ = Very Poor

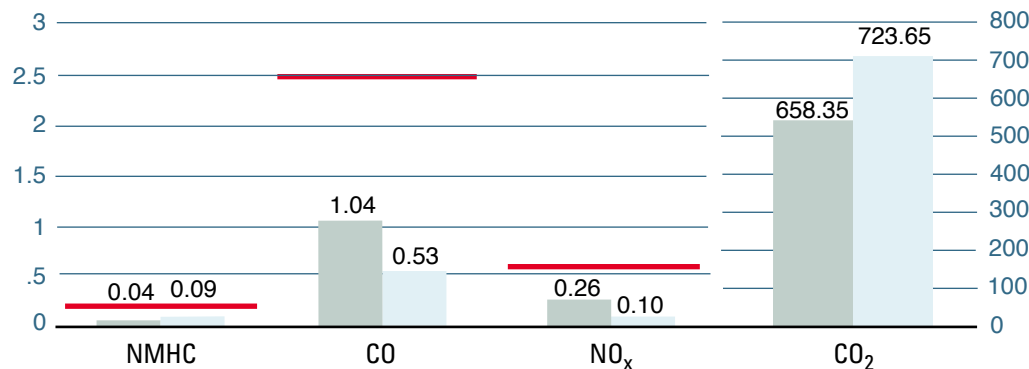
Emissions

■ Bi-LPG

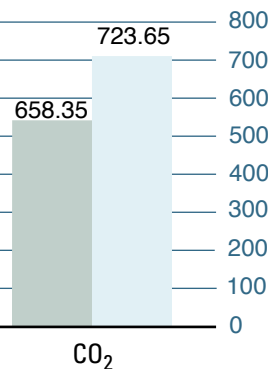
■ Bi-Gasoline

— ULEV

Regulated Exhaust Emissions (g/mi)



CO₂ Emissions (g/mi)



Evaluation Summary

Evaluation results for the bi-fuel F-250 pickup show very little difference in braking, driveability, or handling when tested on either gasoline or LPG. Fuel economy for the F-250 operating on LPG was 26% to 28% less than that measured when operating on gasoline. This is expected because LPG has about 27% less energy per gallon than gasoline. Acceleration tests showed slightly lower results when the pickup was operating on LPG. Differences ranged between 1.5% and 7% quicker for the gasoline acceleration tests. Evaluators for the driveability and handling test gave good overall marks to the F-250 pickup. Ratings were similar when tested on either fuel, with one exception. Although the acceleration times were close, evaluators noticed slower acceleration when operating on LPG. During the cold start tests, the F-250 started at -20°F on gasoline. According to the Owners Guide Supplement for the LPG F-250, the system is designed to start on gasoline if the ambient temperature falls below 20°F. To confirm this, we tested the bi-fuel at -20° F with the LPG tank full, and the gasoline tank empty. As expected, the engine attempted to start on gasoline, but was unsuccessful. A subsequent test at 20°F on LPG proved successful. Emissions results for the F-250 were below the ULEV certification standard for both fuels. Non-methane hydrocarbon and carbon dioxide emissions were lower for the LPG tests; carbon monoxide and oxides of nitrogen emissions were higher. The biggest emissions benefit of LPG shows up in the results for total potency weighted toxics (including benzene, 1,3-butadiene, formaldehyde, and acetaldehyde)*. Potency weighted toxics emissions for the LPG test were 98% lower than those from the gasoline test.

For more information on the calculation of potency weighted toxic emissions, see the section on emissions on the Web site (http://www.ott.doe.gov/otu/field_ops/nve).